Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1-32. (Canceled)

33. (New) A method useful in three-dimensional pose estimation for use with a single camera mounted to a movable portion of a robot, the method comprising:

capturing a number of images of a calibration object by the camera;

determining a set of intrinsic parameters of the camera from at least one of the number of images of the calibration object captured by the camera; and

determining a set of extrinsic parameters of the camera from at least one of the number of images of the calibration object captured by the camera, the set of extrinsic parameters comprising a camera space-to-training space transformation defining a transformation between a camera space reference frame and a training space reference frame.

34. (New) The method of claim 33, further comprising:

positioning the camera with respect to the calibration object.

35. (New) The method of claim 34 wherein positioning the camera with respect to the calibration object comprises positioning the camera orthogonally with respect to a ruled template with a number of features, where a known or determinable physical relationship exists between at least some of the features.

36. (New) The method of claim 34 wherein positioning the camera with respect to the calibration object comprises positioning the camera with respect to a sample of a

type of object the robot will manipulate, the sample having a number of features, where a known or determinable physical relationship exists between at least some of the features.

37. (New) The method of claim 34 wherein capturing a number of images of a calibration object by the camera comprises capturing at least one image at each of a plurality of positions spaced perpendicularly from the calibration object.

38. (New) The method of claim 34 wherein capturing a number of images of a calibration object by the camera comprises capturing at least one image at each of a plurality of different orientations with respect to the calibration object.

39. (New) The method of claim 33 wherein determining a set of intrinsic parameters of the camera from the at least one of the number of images of the calibration object captured by the camera comprises determining at least one of a focal length, a first order radial lens distortion coefficient, a set of coordinates of a center of a radial lens distortion, or a scale factor indicative of a framegrabber scanline resampling uncertainty.

40. (New) The method of claim 33 wherein determining a set of extrinsic parameters of the camera from at least one of the number of images of the calibration object captured by the camera, the set of extrinsic parameters comprising a camera space-to-training space transformation defining a transformation between a camera space reference frame and a training space reference frame comprises determining a respective translation component along three orthogonal axes, and a respective rotation component about the three orthogonal axes.

41. (New) The method of claim 33, further comprising:

determining a camera space-to-tool space transformation based at least in part on at least two of the number of images captured by the camera of the calibration object.

42. (New) The method of claim 33, further comprising:

determining a camera space-to-tool space transformation based on single one of the number of images captured by the camera of the calibration object and on a number of physical coordinates of at least one feature of the calibration object.

43. (New) The method of claim 33, further comprising:

capturing an image of a teaching object of a type of object that will be manipulated by the robot;

selecting a number of features from the captured image of the teaching object;

determining a set of object space coordinates for each of the selected features from the captured image of the teaching object; and

44. (New) The method of claim 43 wherein selecting a number of features from the captured image of the teaching object comprises selecting six features from the captured image of the teaching object.

45. (New) The method of claim 43, further comprising:

determining an object space-to-camera space transformation defining a transformation between an object space reference frame and the camera space reference frame.

46. (New) The method of claim 45, further comprising:

determining a position and an orientation of an object frame in the tool frame reference frame based at least in part on the object frame-to-camera space and camera space-to-tool space transformations.

47. (New) The method of claim 46, further comprising:

providing the position and orientation of the object frame to the robot; and

training an intended operation path inside the object frame.

48. (New) The method of claim 43, further comprising:

capturing a two-dimensional image of a volume containing a target object; and

locating a number of features in the captured image of the target object.

49. (New) The method of claim 48, further comprising:

adjusting a position of the movable portion of the robot if the number of features located in the captured image of the target object is determined to be an insufficient number of features.

50. (New) The method of claim 48, further comprising:

determining an object space-to-camera space transformation based at least in part on a position of at least some of the located features using an algorithm that employs a known or determinable physical relationship between at least some of the located features.

51. (New) The method of claim 50, further comprising:

determining at least one movement of the robot that orients the camera orthogonally with respect to the target object based at least on part on the object space-to-camera space transformation.

52. (New) The method of claim 51, further comprising:

determining a position of the object frame in the tool space reference frame; and

providing an object frame to the robot.

53. (New) An apparatus useful in robotics, the apparatus comprising:

a single camera operable to capture at a number of images of a calibration object by the camera;

means for calibrating the camera, by:

determining a set of intrinsic parameters of the camera from at least one of the number of images of the calibration object captured by the camera; and

determining a set of extrinsic parameters of the camera from at least one of the number of images of the calibration object captured by the camera, the set of extrinsic parameters comprising a camera space-to-training space transformation defining a transformation between a camera space reference frame and a training space reference frame; and

means for estimating a pose of a target object, by:

capturing a two-dimensional image of an volume containing a target object; and

locating at least six features in the captured image of the target object; and

determining an object space-to-camera space transformation based at least in part on a position of at least some of the located features using an algorithm that employs a known or determinable physical relationship between at least some of the located features.

54. (New) The apparatus of claim 53, further comprising:

means for training, comprising:

capturing an image of a teaching object of a type of object that will be manipulated by the robot;

selecting a number of features from the captured image of the teaching object;

determining a set of object space coordinates for each of the selected features from the captured image of the teaching object; and

determining an object space-to-camera space transformation defining a transformation between an object space reference frame and the camera space reference frame.

55. (New) The apparatus of claim 54 wherein the means for calibrating, the means for estimating a pose, and the means for training comprises at least one programmed computer.

56. (New) The apparatus of claim 54 wherein the means for calibrating, the means for estimating a pose, and the means for training comprises at least one computer-readable medium storing instructions operating at least one computer.

57. (New) The apparatus of claim 53 wherein the pose estimating means estimates the pose of the target object further by:

adjusting a position of the movable portion of the robot if the number of features located in the captured image of the target object is determined to be an insufficient number of features.

58. (New) An apparatus useful in robotics, the apparatus comprising:

a single camera operable to capture a number of images of a calibration object by the camera;

means for calibrating the camera, by:

determining a set of intrinsic parameters of the camera from at least one of the number of images of the calibration object captured by the camera; and

determining a set of extrinsic parameters of the camera from at least one of the number of images of the calibration object captured by the camera, the set of extrinsic parameters comprising a camera space-to-training space transformation defining a transformation between a camera space reference frame and a training space reference frame; and

means for estimating a pose of a target object, by:

capturing a two-dimensional image of an volume containing a target object; and

locating at least five features in the captured image of the target object;

determining an object space-to-camera space transformation based at least in part on a position of at least some of the located features using an algorithm that employs a known or determinable physical relationship between at least some of the located features.

59. (New) The apparatus of claim 58 wherein the means for calibrating and the means for estimating a pose comprises at least one programmed computer.

60. (New) The apparatus of claim 58 wherein the means for calibrating and the means for estimating a pose comprises at least one computer-readable medium storing instructions operating at least one computer.

61. (New) The apparatus of claim 58 wherein the pose estimating means estimates the pose of the target object further by:

adjusting a position of the movable portion of the robot if the number of features located in the captured image of the target object is determined to be an insufficient number of features.